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ICESat (GLAS) Science Processing Software Document Series

Volume
Interface Control Document Between
I-SIPS/ISF and CSR
Version 0.2

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Introduction

1.1   Identification of Document

This document provides the interface control for the exchange of files between:

- ICESat Science Investigator-led Processing System (I-SIPS) and the Center for Space Research (CSR) at the University of Texas
- GLAS Instrument Support Facility (ISF) and the Center for Space Research at the University of Texas.

It is a roll-out of Volume 1 (the Management Volume) of the four volumes of NASA software engineering documentation. Its parent document is the GLAS Science Data Management Plan [Reference: Parent Document 2.1b].

Subsequent versions of this document will be uniquely identified by document version and date marks on the cover and individual page footers.

1.2   Scope of Document

The scope of this document is to control all the GLAS-related file exchanges between I-SIPS and the CSR, and between ISF and the CSR.

1.3   Purpose and Objectives of Document

The objectives of this document are: (1)to define the data to be exchanged, and (2) to describe the mechanisms/control for the file exchange interface between I-SIPS, ISF and CSR.

1.4   Document Organization

Sections 1 and 2 contain the introductory and reference document information. Section 3 provides an overview of the I-SIPS/ISF/CSR interface. Section 4 contains the framework for the data exchange, and Section 5 identifies and describes the files to be exchanged.

Appendix A details the content and format of the files to be exchanged.

Supplemental information is presented in the Abbreviations and Acronyms and in the Glossary sections.

1.5   Document Status and Schedule

This document is the Initial Draft of the ICD between I-SIPS/ISF and CSR. Subsequent editions of the document will include updated file exchange and control information.

1.5.1   Items to be Resolved

The following items are to be resolved:

- The content and format of the files to be exchanged.

- The schedule of the file exchange.

- The details of the file exchange framework.

1.5.2   Document Change History

Document Name: Interface Control Document Between I-SIPS/ISF and CSR		
Version Number	**Date**	**Nature of Change**
0.0	January 1999	Initial Document
0.1	March 1999	Updated Information
0.2	May 1999	Updated Information

Related Documentation

This section provides the references for this interface control document. Document references include parent documents, applicable documents, and information documents.

2.1 Parent Documents

Parent documents are those external, higher-level documents that contribute information to the scope and content of this document. The following GLAS documents are parent to this document.

a) *GLAS Science Software Management Plan* (GLAS SSMP), Version 3.0, August 1998, NASA Goddard Space Flight Center Wallops Flight Facility.

b) *GLAS Science Data Management Plan* (GLAS SDMP), Version 3.0, August 1998, NASA Goddard Space Flight Center Wallops Flight Facility.

c) *GLAS Science Software Requirements Document* (GLAS SSRD), Version 2.0, September 1998, NASA Goddard Space Flight Center Wallops Flight Facility.

d) *NASA Earth Observing System Geoscience Laser Altimeter System GLAS Science Requirements Document,* Version 2.01, October 1997, Center for Space Research, University of Texas at Austin.

The GLAS SSMP is the top-level Volume 1 (Management Plan Volume) document of the four volumes of NASA software engineering documentation [Applicable Reference 2.2c]. It dictates the creation and maintenance of the Data Management Plan. This document is a roll out of the Data Management Plan.

2.2 Applicable Documents

Applicable documents include reference documents that are not parent documents. This category includes reference documents that have direct applicability to, or contain policies binding upon, or information directing or dictating the content of this document. The following GLAS, EOS Project, NASA, or other Agency documents are cited as applicable to this interface control document.

a) *NASA Software Documentation Standard Software Engineering Program*, NASA, July 29, 1991, NASA-STD-2100-91.

b) *Science User's Guide and Operations Procedure Handbook for the ECS Project, Volume 4: Software Developer's Guide to Preparation, Delivery, Integration and Test with ECS*, Final, August 1995, Hughes Information Technology Corporation, 205-CD-002-002.

c) *Data Production Software and Science Computing Facility (SCF) Standards and Guidelines*, January 14, 1994, Goddard Space Flight Center, 423-16-01.

d) *EOS Output Data Products, Processes, and Input Requirements*, Version 3.2, November 1995, Science Processing Support Office.

e) *Precision Orbit Determination (POD),* Algorithm Theoretical Basis Document, Version 0.1, December 1996, Center for Space Research, The University of Texas at Austin.

f) *Laser Footprint Location and Surface Profiles*, Algorithm Theoretical Basis Document, Version 0 (Preliminary), December 1996, Center for Space Research, The University of Texas at Austin.

g) *Precision Attitude Determination (PAD)*, Algorithm Theoretical Basis Document, December 1996, Center for Space Research, The University of Texas at Austin.

h) *GLAS Level 0 Instrument Data Product Specification*, Version 2.2, March 17, 1998, NASA Goddard Space Flight Center Wallops Flight Facility.

i) *GLAS Standard Data Products Specification - Level 1*, Version 2.0, December 1998, NASA Goddard Space Flight Center Wallops Flight Facility.

j) *GLAS Standard Data Products Specification - Level 2*, Version 2.0, December 1998, NASA Goddard Space Flight Center Wallops Flight Facility.

Interface Overview

3.1 Summary of Data Flows

Table 3-1 summarizes the data flow between I-SIPS/ISF and the CSR that are specified in Section 5. The data exchange uses industry-standard FTP transfer via the Internet.

In response to standing orders (subscriptions), I-SIPS sends Level 1A data to the CSR for input to their precision attitude and precise attitude computations.

ISF, in response to standing orders, sends supporting data to the CSR, for CSR's computations of precision orbit and precise attitude.

CSR, in response to standing orders, sends precision orbit and precision attitude data to I-SIPS.

CSR, in response to standing orders, sends calibration information for the Stellar Reference System (SRS) and sends recommendations for groundtrack maintenance to the ISF.

Table 3-1   I-SIPS and CSR Interface Overview

Item No.	Source	Destination	File ID	File Name	Transfer Mechanism
1	I-SIPS	CSR	GLA04	SRS and GPS Data File	Push
2	ISF	CSR	GLA SUP 01	GLAS Instrument Operations Plan	TBD
3	ISF	CSR	GLA SUP 06	Predicted Events File	TBD
4	ISF	CSR	GLA SUP 07	Spacecraft Flight Operations Schedule	TBD
5	ISF	CSR	GLA SUP 08	Spacecraft Ephemeris Data File	TBD
6	ISF	CSR	GLA SUP 12	Event Log File	TBD
7	ISF	CSR	GLA (TBD)	Spacecraft Center-of-Gravity File	TBD
8	CSR	I-SIPS	GLA ANC 08	Precision Orbit Data File	Push
9	CSR	I-SIPS	GLA ANC 09	Precision Attitude Data File	Push
10	CSR	I-SIPS	N/A	Software Change Notices	FAX and Express Mail

Table 3-1 I-SIPS and CSR Interface Overview (Continued)

Item No.	Source	Destination	File ID	File Name	Transfer Mechanism
11	CSR	ISF	GLA (TBD)	SRS Calibration File	TBD
12	CSR	ISF	GLA (TBD)	Groundtrack Maintenance File	TBD

Data Exchange Framework

The framework for the data exchange will be the GSFC DAAC V0 file-exchange software. This software is designed to automate the transfer of files utilizing File Transfer Protocol, and to operate with user intervention at a minimum.

The details of this file exchange are TBD.

4.1   Directory Structure

TBD

4.2   Receiving Files

TBD

4.3   Sending Files

TBD

Data Flow Description

5.1 Data Provided to CSR

5.1.1 Files Transferred from I-SIPS to CSR

5.1.1.1 SRS and GPS Data File (GLA04)

Standard Data Product GLA04 is comprised of the Stellar Reference System (SRS) data, the Global Positioning System (GPS) data, and other instrument and spacecraft data. GLA04 is a product of the I-SIPS Level 1A computations, and is transferred from the I-SIPS to the CSR where it is used in the production of precision orbit and precision attitude files. The GPS data in GLA04 is organized in product-sized granules, ready for use in the POD and for archive.

GLA04 includes the following parameters:

- GPS Data [in Receiver-Independent Exchange (Rinex) format]
- Laser Reference Camera Data
- SRS Data
- HRG Gyro
- Spacecraft Star Camera Data

The contents of GLA04 are listed in Tables 3-1, 3-2, and 3-3 of Applicable Document 2.2i (*GLAS Standard Data Products Specification - Level 1*). The format of the file is contained in Appendix A.

5.1.2 Files Transferred from ISF to CSR

5.1.2.1 GLAS Instrument Operations Plan (GLA SUP 01)

The GLAS Instrument Operations Plan provides long range planning for instrument operations events. The contents and format of this file are listed in Appendix A.

5.1.2.2 Predicted Events File (GLA SUP 06)

The Predicted Events File provides shorter-range planning for instrument operations events. The contents and format of this file are listed in Appendix A.

5.1.2.3 Spacecraft Flight Operations Schedule (GLA SUP 07)

The Spacecraft Flight Operations Schedule provides the schedule for spacecraft events, including maneuvers. The contents and format of this file are listed in Appendix A.

5.1.2.4   Spacecraft Ephemeris Data File (GLA SUP 08)

The Spacecraft Ephemeris Data File provides predicted and historical Flight Dynamics events, including the delta V's resulting from maneuvers. The contents and format of this file are listed in Appendix A.

5.1.2.5   Event Log File (GLA SUP 12)

The Event Log File provides the listing of actual spacecraft events and their results. The contents and format of this file are listed in Appendix A.

5.1.2.6   Spacecraft Center-of-Gravity File (GLA [TBD])

The Spacecraft Center-of-Gravity File will include the following information:

- The reference phase center position with respect to the spacecraft center-of-gravity, as a function of time over the mission lifetime

- The reference SLR array position with respect to the spacecraft center-of-gravity, as a function of time over the mission lifetime.

- The location of the spacecraft center-of-gravity with respect to a specified point, as a function of time over the mission lifetime.

5.1.2.7   Near-Realtime Operational Data File (GLA[TBD])

The ISF will provide pass dumps (four-per-day, occurring at approximately six-hours intervals) of GPS data. The purpose of this data is for quick-look analysis; it is not intended to be archived.

5.1.3   Summary of Data Provided to CSR

Table 5-1 summarizes the parameters provided to the CSR by I-SIPS and ISF, for CSR's computations of Precision Orbit Data (GLA 08) and Precision Attitude Data (GLA 09).

Table 5-1   Summary of GLAS Data Provided to CSR

Application	Parameters	Elements	Source File	Source
Spacecraft Position	GPS Data (Rinex Format)	Carrier Phase L1, L2	GLA04	I-SIPS
		Pseudorange L1, L2		
		GPS-System Time		
	Spacecraft Uploaded Ephemeris Data	Orbital Parameters for Onboard Processing	GLA SUP 08	ISF
	Spacecraft Center-of-Gravity File	SLR Array Position with respect to s/c		
		Time History of Changes in s/c c.g.		
Spacecraft Attitude	Uploaded Attitude Control Data	Attitude Control Parameters for System Steering		
	Spacecraft Star Camera Data	TBD	GLA04	I-SIPS
Laser Pointing	GLAS Star Camera Data	TBD	GLA04	I-SIPS
	Laser Pulse Array	LPA		
		Altimeter Data (Shot Time, Raw Range, Hit QA)		
	SRS Data	TBD		
	Gyroscope Data	TBD		

Table 5-1   Summary of GLAS Data Provided to CSR (Continued)

Application	Parameters	Elements	Source File	Source
Instrument Operations	Instrument Operations Plan	Long-Range Planning for Instrument Operation	GLA SUP 01	ISF
	Predicted Events	Short-Term Schedule for Upcoming Instrument Events	GLA SUP 06	ISF
	Spacecraft Flight Operations Schedule	Near-Term Schedule for Instrument Events	GLA SUP 07	ISF
	Event Log File	Executed Instrument Events	GLA SUP 12	ISF
	Solar Array Start/Stop/ Freeze Times	Predicted and Past Solar Array Maneuvers	GLA SUP 08	ISF
	Maneuver Periods	Predicted and Past Orbital Maneuvers		
		Predicted and Observed Delta V's		
	Spacecraft Rotation	Predicted and Past Spacecraft Rotations		
Pass Dump	Near-Realtime Operational Data (Rinex Format)	Four six-hour dumps of GPS data per day	GLA [TBD]	ISF

5.2   Data Provided by CSR

5.2.1   Files Transferred from CSR to I-SIPS

5.2.1.1   Precision Orbit Data File (GLA ANC 08)

The Precision Orbit Data File is produced by the CSR, and transferred to I-SIPS where it is used to geolocate Level 1B and Level 2 products. The File contains orbital positions at 30-second intervals, in the International Celestial Reference Frame (ICRF). The use of this file at I-SIPS will require an interpolator.

The file's header will identify which input files were used for computing the precision orbit.The contents and format of this file are detailed in Appendix A.

5.2.1.2   Precision Attitude Data File (GLA ANC 09)

The Precision Attitude Data File is produced by the CSR, and transferred to I-SIPS where it used to compute the Laser Spot Locations. The File contains attitude/pointing vectors at 0.025-second intervals, in the ICRF.

The file's header will identify which input files were used for computing the precision attitudes. The contents and format of this file are detailed in Appendix A.

5.2.1.3   Precision Attitude Data Software

CSR will provide a copy of the software that produces the Precision Attitude Data for I-SIPS. Any PAD software updates affecting the GLAS-related output will also be provided.

5.2.1.4   Software Change Notices

CSR will provide copies of any relevant (UTOPIA or other) Software Change Notices, the nature of which may affect the precision orbit data, precision attitude data, or other data provided to I-SIPS.

5.2.1.5   Solar Angle File (GLA [TBD])

The SolarAngle File contains time-ordered solar angles, to be used for surface reflectance calculations. The file contains three-element Earth-Sun vectors in the International Earth Rotation Service Terrestrial Reference Frame (ITRF), at 15-minute intervals.

5.2.1.6   Center of Gravity-to-Laser Reference File (GLA [TBD])

The Center of Gravity-to-Laser Reference File contains vector distances which relate the spacecraft c.g. to the laser measurement reference.

5.2.1.7   Pulse Information File (GLA [TBD])

The Pulse Information File contains information on the pulse:

- Orientation
- Semi-Major Axis
- Semi-Minor Axis

- Intensity

5.2.1.8   GPS-to-UTC Correction File

The GPS-to-UTC Correction File contains the date/times of leap seconds, used in the conversion of GPS time to UTC time.

5.2.1.9   ICRF-to-ITRF Transformation Software

This software provides the nine-element reference system transformation from ICRF to ITRF.

5.2.2   Files Transferred from CSR to ISF

5.2.2.1   SRS Calibration File (GLA [TBD])

The SRS Calibration File contains calibration information for the Stellar Reference System.

5.2.2.2   Groundtrack Maintenance File (GLA [TBD])

The Groundtrack Maintenance File contains CSR recommendations for orbital maneuvers, for maintaining the spacecraft's groundtrack within a prescribed repeat-orbit longitude window.

5.2.2.3   Solar Array Freeze File (GLA [TBD])

The Solar Array Freeze File lists the times for which the solar arrays were non-articulated, during overflights of the polar regions.

5.2.3   Summary of Data Provided by CSR

Table 5-2 summarizes the parameters provided by CSR.

Table 5-2   Summary of GLAS Data Provided by CSR

Application	Parameters	Elements	Source File	Destination
Spacecraft Position	Precision Orbit Data	Spacecraft Coordinates vs. time	GLA ANC 08	I-SIPS
Attitude	Precision Off-Nadir Angles	Pointing Vectors	GLA ANC 09	I-SIPS
	Nominal Determination of Off-Nadir Angle for LIDAR	Pointing Angles (not jitter-corrected)		
	Software for Computation of Precision Attitude Data	TBD	TBD	I-SIPS
POD/PAD Quality Assessment	Software Change Notices	N/A	N/A	I-SIPS

Table 5-2   Summary of GLAS Data Provided by CSR

Application	Parameters	Elements	Source File	Destination
Solar Angles	Angles	TBD	GLA [TBD]	I-SIPS
Spacecraft Center of Gravity- to-Laser Reference	Vector Distance as Function of Date	TBD	GLA [TBD]	I-SIPS
Maneuver Times	Solar Array Freeze Periods	Start/Stop Times of Non-Articulation	GLA [TBD]	I-SIPS
	Maneuver Periods	Start/Stop Times		
	Groundtrack Maintenance	Recommendations for Maneuvers	GLA [TBD]	I-SIPS
Timing (GPS-to-UTC)	Leap Second Table	Dates/Times of Leap Seconds	GLA [TBD]	I-SIPS
Pulse Information	Orientation	TBD	GLA [TBD]	I-SIPS
	Semi-Major/Semi-Minor Axes	TBD		
	Intensity	TBD		
Stellar Reference System	Calibration	TBD	GLA [TBD]	ISF
Reference Frame Transformation	ICRF-to-ITRF Transformation	TBD	GLA[TBD]	I-SIPS

File Contents and Formats

A.1   GLA04

The contents of this file are found in Tables 3-1, 3-2, and 3-3 of Applicable Document 2.2i (*GLAS Standard Data Products Specification - Level 1).* The format of the file is TBD.

A.2   GLA SUP 01

File Contents and Format are TBD.

A.3   GLA SUP 06

File Contents and Format are TBD.

A.4   GLA SUP 07

File Contents and Format are TBD.

A.5   GLA SUP 08

File Contents and Format are TBD.

A.6   GLA SUP 12

File Contents and Format are TBD.

A.7   Spacecraft Center-of-Gravity File

File Contents and Format are TBD.

A.8   GLA ANC 08

The orbital positions, in ICRF at 30-second intervals, will be comprised of:

- Time, X, Y, and Z [32 bytes]

Detailed File Contents and Format are TBD.

A.9   GLA ANC 09

The attitude/pointing vectors, in ICRF at 0.025-second intervals, will be comprised of:

- Time, $\cos \alpha \cos \beta \cos \gamma$, Spot: Az, a, e [56 bytes]

Detailed File Contents and Format are TBD.

A.10 SRS Calibration File

File Contents and Format are TBD.

A.11 Groundtrack Maintenance File

File Contents and Format are TBD.

A.12 ICRF-to-ITRF Transformation File

File Contents and Format are TBD.

Abbreviations & Acronyms

CSR	Center for Space Research at the University of Texas
DAAC	Distributed Active Archive Center
EDOS	EOS Data and Operations System
EOC	EOS Operating Center
EOS	NASA Earth Observing System Mission Program
EOSDIS	Earth Observing System Data and Information System
GLAS	Geoscience Laser Altimeter System instrument or investigation
GPS	Global Positioning System
GSFC	Goddard Space Flight Center
GSFC/WFF	Goddard Space Flight Center/Wallops Flight Facility
ICRF	International Celestial Reference Frame
ID	Identification
ICESat	Ice, Cloud, and Land Elevation Satellite
IEEE	Institute for Electronics and Electrical Engineering
ISF	Instrument Support Facility
ITRF	InternationalEarth Rotation Service Terrestrial Reference Frame
LASER	Light Amplification by Stimulated Emission of Radiation
LIDAR	Light Detection and Ranging
N/A	Not (/) Applicable
NASA	National Aeronautics and Space Administration
NOAA	National Oceanic and Atmospheric Administration
POD	Precision Orbit Determination
SCF	Science Computing Facility
SDPS	Science Data Processing Segment
TBD	to be determined, to be done, or to be developed
UNIX	the operating system jointly developed by the AT&T Bell Laboratories and the University of California-Berkeley System Division

Glossary

file	A collection of data stored as records and terminated by a physical or logical end-of-file (EOF) marker. The term usually applies to the collection within a storage device or storage media such as a disk file or a tape file. Loosely employed it is used to indicate a collection of GLAS data records without a standard label. For the Level 1A Data Product, the file would constitute the collection of one-second Level 1A data records generated in the SDPS working storage for a single pass.
header	A text and/or binary label or information record, record set, or block, prefacing a data record, record set, or a file. A header usually contains identifying or descriptive information, and may sometimes be embedded within a record rather than attached as a prefix.
label	The text and/or binary information records, record set, block, header, or headers prefacing a data file or linked to a data file sufficient to form a labeled data product. A standard label may imply a standard data product. A label may consist of a single header as well as multiple headers and markers depending on the defining authority.
Level 0	The level designation applied to an EOS data product that consists of raw instrument data, recorded at the original resolution, in time order, with any duplicate or redundant data packets removed.
Level 1A	The level designation applied to an EOS data product that consists of reconstructed, unprocessed Level 0 instrument data, recorded at the full resolution with time referenced data records, in time order. The data are annotated with ancillary information including radiometric and geometric calibration coefficients, and georeferencing parameter data (i.e., ephemeris data). The included, computed coefficients and parameter data have not however been applied to correct the Level 0 instrument data contents.
Level 1B	The level designation applied to an EOS data product that consists of Level 1A data that have been radiometrically corrected, processed from raw data into sensor data units, and have been geolocated according to applied georeferencing data.
Level 2	The level designation applied to an EOS data product that consists of derived geophysical data values, recorded at the same resolution, time order, and geo-reference location as the Level 1A or Level 1B data.
Level 3	The level designation applied to an EOS data product that consists of geo-physical data values derived from Level 1 or Level 2 data, recorded at a tem-porally or spatially resampled resolution.
Level 4	The level designation applied to an EOS data product that consists of data from modeled output or resultant analysis of lower level data that are not directly derived by the GLAS instrument and supplemental sensors.

metadata   The textual information supplied as supplemental, descriptive information to a
                  data product. It may consist of fixed or variable length records of ASCII data
                  describing files, records, parameters, elements, items, formats, etc., that may
                  serve as catalog, data base, keyword/value, header, or label data. This data
                  may be parsable and searchable by some tool or utility program.

product   Specifically, the Data Product or the EOS Data Product. This is implicitly the
                  labeled data product or the data product as produced by software on the
                  SDPS or SCF. A GLAS data product refers to the data file or record collection
                  either prefaced with a product label or standard formatted data label or linked
                  to a product label or standard formatted data label file. Loosely used, it may
                  indicate a single pass file aggregation, or the entire set of product files con-
                  tained in a data repository.

Standard Data   Specifically, a GLAS Standard Data Product. It represents an EOS ALT-L/
Product   GLAS Data Product produced on the EOSDIS SDPS for GLAS data product
                  generation or within the GLAS Science Computing Facility using EOS science
                  community approved algorithms. It is routinely produced and is intended to be
                  archived in the EOSDIS data repository for EOS user community-wide access
                  and retrieval.